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RESEARCH ARTICLE

The first arrival of the Chinese sand roach *Polyphaga* cf. *plancyi* (Blattodea: Corydiidae) in Europe

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Abstract

Polyphaga plancyi Bolívar, 1883, also known as Chinese sand roach, it is a large Corydiidae species with a native distribution that includes several Chinese provinces and southern part of the Russian Far East. It is a well-known insect in traditional Chinese medicine, and the biological activity of the compounds isolated from it are actively studied. So far, there are no records of this species outside its natural range, at least outside China. In this article, we present the first record of *P.* cf. *plancyi* specimen collected in Europe, probably imported from Shanghai. The specimen was recognized as a non-native cockroach species to Europe via photo posted on social media, and it was subsequently taxonomically identified. Details of its possible origin, its morphology, importance of citizen science, as well as annotations on the other synanthropic cockroaches in Serbia are provided.

Keywords

alien species, allochthonous species, China, citizen science, cockroach.

Introduction

The order Blattodea includes insects known as cockroaches and termites, with 7,570 extant known species, of which 4,641 are cockroaches, while 2,929 are termites (Beccaloni and Eggleton 2013; Krishna et al. 2013). A few cockroaches are important pests, they colonize human settlements and enter houses and buildings, and their

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populations are often very large (Cochran 2009). Some species of cockroaches are also of great medical importance, as they can be vectors of pathogenic bacteria, transmit viruses, protozoa, fungi, helminth eggs, and serve as intermediate hosts of some pathogenic helminths (Cochran 1999).

Among Blattodea, the family Corydiidae Saussure, 1864 (formerly known as Polyphagidae), includes cockroaches with a unique combination of morphological features, such as the presence of inflated clypeus transversally divided into anteclypeus and postclypeus, anal area of wings (when present) with single fold, and the R2 sclerite of the male genitalia with two tubercles (Grandcolas 1999; Beccaloni and Eggleton 2013; Estrada-Álvarez and Guadarrama 2013). The family includes about 40 genera and about 215 species globally (Beccaloni and Eggleton 2013; Qiu et al. 2018). In Europe, this family is represented by a small number of taxa, distributed exclusively in the Mediterranean area (Bohn 2022). Although still restricted to the Mediterranean region, the most widespread and well-known corydiid species is *Polyphaga aegyptiaca* (Linnaeus, 1758) which inhabits some countries neighboring Serbia (Hristov and Chobanov 2016; Bohn 2022). This species, also named the Egyptian desert cockroach, is the only representative of its genus in Europe (Bohn 2022). Until now, no species of the family Corydiidae has been recorded in Serbia.

Polyphaga plancyi Bolívar, 1883 also known as Chinese sand roach, is a large and oval corydiid species, with a body length 20.5–23.6 mm in males, and 31.2–36.4 mm in females (Fig. 1). Its distribution includes China (Beijing, Hebei, Henan, Hunan, Jiangsu, Shaanxi, Shandong and Shanxi provinces) and Russia (southern Baikal) (Qiu et al. 2018). The unpublished data indicates that *P. plancyi* originally occured in Northern China, but due to its medicinal value, it was introduced to southern part of the country during 1970s and 1980s (Qiu et al. 2018). It is known that the Chinese sand roach can be found in human dwellings (Qiu et al. 2018). From the other species of the genus *Polyphaga* Brullé, 1835, males can be distinguished by dark, flatter and wider body, while females can be very easily recognized by the presence of distinct yellowish markings and very short and sparse hairs on the body margins (Chopard 1929; Qiu et al. 2018). The mitochondrial genome of *P. plancyi* is completely sequenced since 2016 and it consists of 15,547 base pairs and 37 genes (Liu et al. 2016). Together with *Eupolyphaga sinensis* (Walker, 1868), *P. plancyi* is an important species in traditional Chinese medicine and there are numerous articles dealing with the investigation of biological effects of various compounds isolated from these cockroaches (Zhu et al. 2016; Zhu et al. 2020a, 2020b; Xie et al. 2021).

Material and methods

A photo of a cockroach posted on Facebook group of insect lovers, enthusiasts and citizen scientists named "Insekti Srbije (Insects of Serbia)" immediately caught our attention because we realized the specimen does not belong to native European entomofauna. The specimen was hand-collected from the floor of a warehouse in

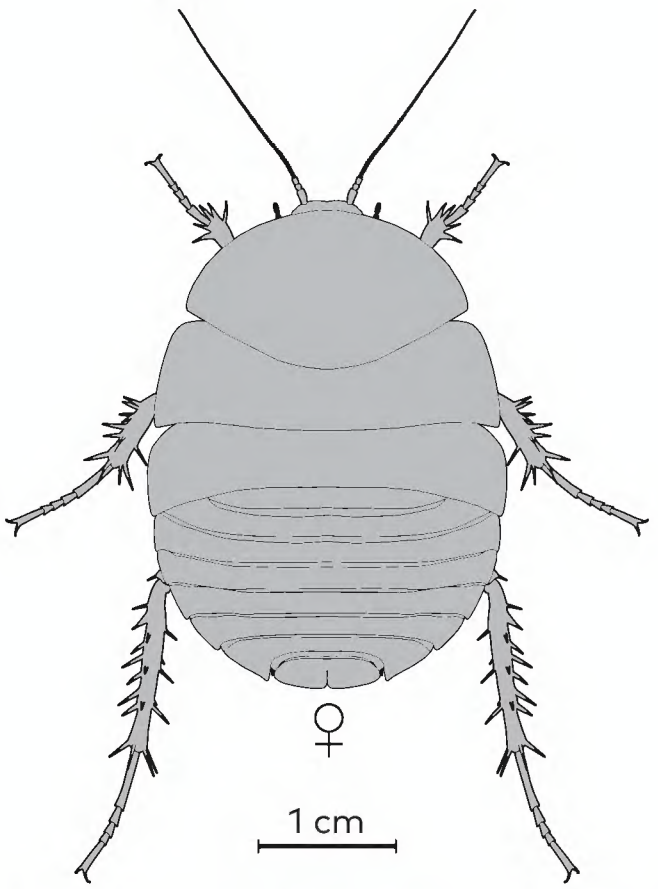

Figure 1. A general morphology (dorsal view) of *Polyphaga* cf. *plancyi* Bolívar, 1883 (drawing by N. Vesović).

suburban Belgrade, Serbia, on October 26, 2022. Later that day, it was taken over from its collector and kept alive in the terrarium of the first author. It was fed on banana, bread and protein food for aquarium fish. Species identification was performed using the keys, redescription and illustrations from Qiu et al. (2018). Photographs of the *P. plancyi* specimen were taken using a Nikon D5300 digital camera equipped with Tamron SP 90mm f/2.8 Di Macro lens and Sigma EM-140 DG ring flash. The habitus drawing was made in Adobe Photoshop CS6, version 13.0.1.

Results

The only specimen, an adult female was found in a warehouse in Radiofar (Surčin municipality), suburban neighborhood on the outskirts of the Serbian capital, Belgrade. Precisely, the specimen was found in a part of a warehouse with goods imported from Shanghai, China. At the moment of collecting, the insect was smeared in mud and covered with dust.

Polyphaga cf. *plancyi* Bolívar, 1883

Material examined: SERBIA; 1♀; Belgrade, Surčin municipality, about one kilometer east of the center of the suburban neighborhood of Radiofar (44.826265, 20.315071), in the vicinity of Radiofar Forest; 26.10.2022; leg. A. Đurišić (Fig. 2).

Figure 2. Habitus (dorsal view) of *Polyphaga* cf. *plancyi* Bolívar, 1883 female found in suburban Belgrade, Serbia (photo N. Vesović).

Brief description of the specimen - General appearance (Figs 1, 2): apterous, body large, oval (length 34.9 mm, maximum width 23.9 mm), bare, blackish to dark brown, tinted and lighter towards the edges of the thorax and abdomen, with the prominent yellowish, orange and reddish markings on the body. The whole dorsal surface is covered with small, tooth-like protuberances which gives the impression of sandpaper surface. Head hypognathous, round and black (Fig. 3); eyes small, elongated and slightly reniform. Clypeus is divided into anteclypeus and postclypeus, head surface almost bare except genae, labrum and palpi. Antennae black, short, 17.0 mm in length, do not exceed the length of the thorax, composed of 85–86 antennomeres whose diameter gradually decreases towards the apex; thorax: pro-,

meso- and metanotum are shield-like. Pronotum in dorsal view covers the head, tinted from dark brown, in the medio-posterior area, to yellowish - ochre at the anterior margin, with numerous black protuberances over the entire surface and prominent black markings in the median region. The pronotal edge is black, almost bare, except the posterior margin which has short, dense, yellowish-golden hairs, and the anterior margin with very short hairs. Pronotum ochre-colored ventrally and bare, with a dark brown posterior surface and a hair-covered surface above the head (Fig. 3). Mesonotum wide, dorsally tinted from dark brown medially, ochre-colored anteriorly and blackish at the posterior margin, with prominent black markings medially and a single pale marking medioanteriorly, with numerous

Figure 3. The head and ventral view of the thorax of *Polyphaga* cf. *plancyi* Bolívar, 1883 female found in suburban Belgrade, Serbia (photo N. Vesović).

black protuberances and with dense, short golden hairs at the posterior margin. Mesonotal surface is bare and ochre-colored ventrally with a blackish margin. Metanotum dorsally tinted, dark brown medioposteriorly to pale, ochre-colored at the antero-lateral margin, with prominent black markings and two pale markings, with numerous black protuberances and dense, short, golden hairs at the posterior margin. Metanotal surface bare, ochre-colored ventrally, with a blackish margin. Legs are completely black, strong, bare, with coxae slightly flattened. Fore femora with 1–2 apical black spines, middle and hind femora with one apical black spine. Tibiae with black, flexible spines, fore tibiae with 9–10 spines in the apical half (Fig. 3), middle and hind tibiae with 16 and 23 spines respectively over the entire surface except the very basal part, arolia absent. Abdomen: tergites are wide, glabrous, dark, with prominent light markings speckled with black circular markings near the lateral margin, with numerous protuberances. Sternites are glabrous, almost uniformly dark except lighter markings near the lateral margins. Anal cerci short, black, dorsally mostly covered by tergites, with a few prominent hairs. All morphological features were in accordance with the redescription in Qiu et al. (2018).

Annotations to the other synanthropic cockroach species in Serbia

Blatta orientalis Linnaeus, 1758

Available published records: Živojinović (1950); Hristovski (1972).

The oriental cockroach, *B. orientalis*, is probably the most common synanthropic cockroach species in Serbia. It is distributed across the country, although there is a significant absence of faunistic data. The previous data show that this species is exclusively related to anthropogenic habitats (especially cities). A total of 241 records exist in the database of insects of Serbia, Alciphron (www.alciphron.habiprot.org.rs/) and the species was recorded at numerous localities in the city of Belgrade, Stara Pazova, Vrčin, Valjevo, Rajac Mt., Zaječar, Temska, Divčibare, Petnica, Malo Gradište, Beli Potok, Sremska Kamenica, Sremska Mitrovica, Novi Sad, Fruška Gora Mt., Zrenjanin, Mladenovac, Bela Crkva, Ada, Deliblato, Šid, Banatski Dvor, Bogatić, Stajićevo, Zasavica I, Češko Selo, and Bački Monoštor (Vujić 2022).

Blattella germanica Linnaeus, 1767

Available published records: Živojinović (1950); Hristovski (1972).

The German cockroach, *B. germanica*, together with *B. orientalis*, is commonly found in anthropogenic habitats in Serbia. Same as for *B. orientalis*, there is significant lack of faunistic data on the distribution of this species in the country. A total of 44 records exist in the database of insects of Serbia, Alciphron, and localities of these data are Belgrade, Vrčin, Rajac Mt., Zaječar, Temska, Divčibare, Novi Sad, Zrenjanin, and Sremska Mitrovica (Vujić 2022).

Periplaneta americana (Linnaeus, 1758)

Contrary to previously mentioned species, the American cockroach, *P. americana*, it is rarely found in the country. Until now, the species was found only three times in Belgrade, in a very small area of only a few hundred meters. As to date, there are no published data about presence of this species in Serbia, so the first records are presented herein.

New records: SERBIA; 2♀; Belgrade, Hotel "Srbija", 44.784303, 20.495889; 25.01.2020; leg. M. Vujić, stored in the collection of the first author (numerous specimens observed around a manhole during an unusually warm winter night); Belgrade, Šumice neighborhood, 44.784113, 20.501275; 19.10.2020., obs. M. Vujić (one trampled specimen on the sidewalk); Belgrade, near "Vojislav Ilić" Elementary School, 44.790618, 20.498054; 04.06.2021., obs. M. Vujić (one dead specimen observed on the sidewalk). All the records are stored in the Alciphron database of insects of Serbia (Vujić 2022).

Except aforementioned synanthropic species, there are also some exotic cockroaches common in pet trade in Serbia, such as Turkestan cockroach, *Shelfordella lateralis* (Walker, 1868); Guyana spotted roach, *Blaptica dubia* Serville, 1838; Death's head cockroach, *Blaberus craniifer* Burmeister, 1838; Brazilian cockroach, *Blaberus giganteus* (Linnaeus, 1758); Madagascar hissing cockroach, *Gromphadorhina portentosa* (Schaum, 1853), and Halloween hisser, *Elliptorhina javanica* (Hanitsch, 1930). The first species belongs to family Blattidae, while the others belong to family Blaberidae. None of them have been reported to have succeeded in establishing feral populations and have not been recorded off-breeding in Serbia.

Discussion

The specimen cannot be taxonomically identified with absolute certainty given that only one female was found. The general body appearance, morphological features of *Polyphaga* females, as well as possible locality of origin, all suggest that it is indeed *P. plancyi*. However, due to the lack of males collected (whose genitalia are necessary for reliable species identification), and our current inability to conduct molecular analyses with the aim of confirmation the species, the specimen should be treated as *Polyphaga* cf. *plancyi*. There is a slight possibility that the specimen belongs to some other congeneric species or the locality of origin is not China. Given the circumstances in which the specimen was found, it is almost clear that *P.* cf. *plancyi* entered Serbia together with imported goods from China. Since only one female was found, it is most likely there is no established population of this species in Serbia, but due to the extent trade between Serbia (Europe in general) and China, there is a real possibility that this might happen in the future. The probability that the population is already established and not registered is less likely. As it is known that *P. plancyi* occurs in human settlements in China, it is not unrealistic to expect that the species can survive,

live and reproduce synanthropically in Serbia, especially since it is known from similar latitudes in its native range in Asia (Qiu et al. 2018). Although the breeding of exotic cockroaches is widespread in Serbia, we believe that it is highly unlikely that this specimen came from a breeding ground. This is due to the fact that *P. plancyi* is not one of the species present in pet trade, as well as due to the circumstances in which specimen was found (near the imported goods). In the more likely scenario, a living specimen was transported together with goods from China and a population probably has not yet been established. It is important to emphasize the capability of the species to survive a long period of time without available food and moisture. The settlement Radiofar, where the only specimen was found, is situated not far from the Belgrade Nikola Tesla Airport, the largest and busiest airport in the country. Although we cannot confirm whether the species arrived with the goods by air, it is more likely that it arrived via ship cargo. Data on the import of specific goods are not fully available to us, but due to the nature of the imported goods, they are more likely to have been delivered by ship. This type of transportation significantly increases the time an individual has to survive with limited resources. The data on the maximum time of starvation among cockroaches are not numerous. Willis and Lewis (1957) found that depending on the conditions, some cockroach species can live for a considerable period of time without food, sometimes even in conditions of low humidity. Gunn (1935) and Willis and Lewis (1957) found that species with larger body dimensions (e.g. *B. orientalis* and *P. americana*) have a lower rate of water loss compared to smaller-bodied ones (e.g. *B. germanica*). The maximum starvation time is unknown for *P. plancyi*, but if one had to make a prediction based on body dimensions, it should be able to survive for a long time (enough to withstand a trip from China to Serbia).

This first record of *P.* cf. *plancyi* in Serbia (actually in Europe) is a result of citizen science. Namely, in the last couple of years it has been one of the most important ways to obtain information on certain, unknown, or allochthonous species, as well as for monitoring a particular species. The participation of citizens in online public platforms/databases for collecting data on biodiversity and usage of specialized social media groups (or communities) has already resulted in a large number of newly recorded species, or new localities of occurrence for certain species in Serbia (e.g. Bila Dubaić et al. 2021; Vujić et al. 2021; Nadaždin and Šeat 2022).

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